

Generate Collection

Jul 29, 2003

TITLE: Adaptive antenna for use in wireless communication systems

This application claims the benefit of U.S. Provisional Application No. 60/234,485, filed on Sep. 22, 2000, and is a Continuation-in-part of U.S. patent application Ser. No. 09/579,084 filed May 25, 2000 now U.S. Pat. No. 6,304,215 entitled "A Method of Use for an Adaptive Antenna in Same Frequency Networks" which is a divisional of now issued U.S. Pat. No. 6,100,843 filed Dec. 11, 1998 entitled "Adaptive Antenna for Use in Same Frequency Networks" which is a continuation of U.S. patent application Ser. No. 09/157,736 filed Sep. 21, 1998 now abandoned entitled "Method and Apparatus Providing an Adaptive Antenna For Use in Same Frequency Networks," the entire teachings of all are incorporated herein by reference.

It is also to be understood by those skilled in the art that FIG. 1 may be a standard cellular type communication system such as a CDMA, TDMA, GSM or other system in which the radio channels are assigned to carry data and/or voice or between the base stations 104 and subscriber units 101. In a preferred embodiment, FIG. 1 is a CDMA-like system, using code division multiplexing principles, such as those defined in the IS-95B standards for the air interface.

To optimally set the phase shift for each phase shifter 111 through 115 in antenna 100, phase control values are provided by the controller 140. Generally, in the preferred embodiment, the controller 140 determines these optimum phase settings during idle periods when laptop computer 150 is neither transmitting nor receiving data via antenna 100. During this time, a received signal, for example, a forward link pilot signal 190, that is continuously sent from base station 160 and that is received on each antenna element 101 through 105. That is, during idle periods, the phase shifters 111 through 115 are adjusted to optimize reception of the pilot signal 190 from base station 160, such as by maximizing the received signal energy or other link quality metric.

The processor 140 thus determines an optimal phase setting for each antenna element 101 through 105 based on an optimized reception of a current pilot signal 190. The processor 140 then provides and sets the optimal phase for each adjustable phase shifter 111 through 115. When the antenna apparatus 100 enters an active mode for transmission or reception of signals between the base station 160 and the laptop 150, the phase setting of each phase shifter 111 through 115 remains as set during the previous idle time period.

FIG. 3 shows steps 301 through 306 performed by the controller 140 according to one embodiment of the invention. In order to determine the optimal phase settings for phase shifters 111 through 115 by the first "search" method, steps 301 through 306 are performed during idle periods of data reception or transmission, such as when a pilot signal 190 is being transmitted by the base station 160.

During long periods of idle time, step 308 is executed which repeats the process periodically. Step 308 accounts for the fact that the antenna 100 might be moved and reoriented during idle periods, thus affecting the direction and orientation of the

base station in relation to the antenna 100.

Detailed Description Text (48):

To optimally set the impedance for each selectable impedance component 711 through 715 in the antenna apparatus 700, the selectable impedance components 711-715 control values are provided by the controller 140 (FIG. 2). Generally, in the preferred embodiment, the controller 140 determines these optimum impedance settings during idle periods when the laptop computer 150 is neither transmitting nor receiving data via the antenna apparatus 700. During this time, a received signal, for example, a forward link pilot signal 190, that is continuously sent from the base station 160 is received on each passive antenna element 701 through 705 and active antenna element 706. That is, during idle periods, the selectable impedance components 711 through 715 are adjusted to optimize reception of the pilot signal 190 from the base station 160, such as by maximizing the received signal energy or other link quality metric.

Detailed Description Text (49):

The processor 140 thus determines an optimal phase setting for each passive antenna element 701 through 705 based on an optimized reception of a current pilot signal 190. The processor 140 then provides and sets the optimal impedance for each selectable impedance component 711 through 715. When the antenna apparatus 700 enters an active mode for transmission or reception of signals between the base station 160 and the laptop 150, the impedance settings of the adjustable impedance components 711 through 715 remain as set during the previous idle time period.

Detailed Description Text (74):

FIG. 12 shows steps 1201 through 1206, which parallel steps 301 through 306 (FIG. 3), performed by the controller 140 according to one embodiment of the invention. In order to determine the optimal impedance settings for selectable impedance components 711 through 715 by the first "search" method, steps 1201 through 1206 are performed during idle periods of data reception or transmission, such as when a pilot signal 190 is being transmitted by the base station 160.

Detailed Description Text (77):

During long periods of idle time, step 1208 is executed, which repeats the process periodically. Step 1208 accounts for the fact that the antenna apparatus 700 might be moved and re-oriented during idle periods, thus affecting the direction and orientation of the base station in relation to the antenna apparatus 700.

Other Reference Publication (13):

Milne, R.M.T., "A Small Adaptive Array Antenna for Mobile Communications," IEEE APS International Symposium Digest, 1985, pp 797-800.

Other Reference Publication (23):

Scott, N.L., et al., "Diversity Gain from a Single-Port Adaptive Antenna Using Switched Parasitic Elements Illustrated with a Wire and Monopole Prototype," IEEE Trans. Antennas and Propagation, vol. 47, No. 6, Jun. 1999, pp. 1066-1070.

CLAIMS:

1. An antenna apparatus for use with a subscriber unit in a wireless communication system, the antenna apparatus comprising: at least one active antenna element; a plurality of passive antenna elements within an electromagnetic coupling distance of said at least one active antenna element; a like plurality of selectable impedance components, each (i) respectively electrically coupled to one of the passive antenna elements and (ii) independently selectable; and a processor coupled to the selectable impedance components (a) to affect the phase of respective, re-radiated, link signals to be communicated between a base station and the subscriber unit by said at least one active antenna element to form a composite beam that may be positionally directed between the base station and subscriber unit and (b) to determine an essentially optimal impedance setting during an idle time based on a signal sent to the subscriber unit received during the idle time.

29. The antenna apparatus as claimed in claim 1, wherein the signal received during the idle time is a signal continuously sent from base station.

30. The antenna apparatus as claimed in claim 1, wherein the signal received during the idle time is a pilot signal.

31. A method for use with a subscriber unit in a wireless communication system, the method comprising: providing an RF signal to or receiving one from an antenna assemblage having at least one active antenna element and multiple passive antenna elements electromagnetically coupled to said at least one active antenna element; selecting an impedance state of independently selectable impedance components electrically coupled to respective passive antenna elements in the antenna assemblage affecting the phase of respective, re-radiated, link signals communicated between a base station and the subscriber unit by said at least one active antenna element to form a composite beam that may be communicated between the base station and the subscriber unit; and determining an essentially optimal impedance setting during an idle time based on a signal sent to the subscriber unit received during the idle time.

46. The method as claimed in claim 31, wherein the signal received during the idle time is a signal continuously sent from base station.

47. The method as claimed in claim 31, wherein the signal received during the idle time is a pilot signal.

48. An antenna apparatus for use with a subscriber unit in a wireless communication system, the antenna apparatus comprising: providing an RF signal to or receiving one from an antenna assemblage having at least one active antenna element and multiple passive antenna elements electromagnetically coupled to said at least one active antenna element; means for selecting an impedance state of independently selectable impedance components electrically coupled to respective passive antenna elements in the antenna assemblage; means for affecting the phase of respective, re-radiated, link signals communicated between a base station and the subscriber unit by said at least one active antenna element to form a composite beam that may be communicated between the base station and the subscriber unit; and means for determining an essentially optimal impedance setting during an idle time based on a signal sent to the subscriber unit received during the idle time.

49. The antenna apparatus as claimed in claim 48, wherein the signal received during the idle time is a signal continuously sent from base station.

50. The antenna apparatus as claimed in claim 48, wherein the signal received during the idle time is a pilot signal.

WEST☐

Generate Collection

L3: Entry 1 of 20

File: USPT

Jul 29, 2003

US-PAT-NO: 6600456

DOCUMENT-IDENTIFIER: US 6600456 B2

TITLE: Adaptive antenna for use in wireless communication systems

DATE-ISSUED: July 29, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Gothard; Griffin K.	Satellite Beach	FL		
Keel, Jr.; Alton S.	Hellum	PA		
Snyder; Christopher A.	Palm Bay	FL		
Chiang; Bing	Melbourne	FL		
Richeson; Joe T.	Melbourne	FL		
Wood; Douglas H.	Palm Bay	FL		
Proctor, Jr.; James A.	Indialantic	FL		
Gainey; Kenneth M.	Satellite Beach	FL		

ASSIGNEE-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY	TYPE CODE
Tantivy Communications, Inc.	Melbourne	FL			02

APPL-NO: 09/ 859001 [PALM]

DATE FILED: May 16, 2001

PARENT-CASE:

RELATED APPLICATION(S) This application claims the benefit of U.S. Provisional Application No. 60/234,485, filed on Sep. 22, 2000, and is a Continuation-in-part of U.S. patent application Ser. No. 09/579,084 filed May 25, 2000 now U.S. Pat. No. 6,304,215 entitled "A Method of Use for an Adaptive Antenna in Same Frequency Networks" which is a divisional of now issued U.S. Pat. No. 6,100,843 filed Dec. 11, 1998 entitled "Adaptive Antenna for Use in Same Frequency Networks" which is a continuation of U.S. patent application Ser. No. 09/157,736 filed Sep. 21, 1998 now abandoned entitled "Method and Apparatus Providing an Adaptive Antenna For Use in Same Frequency Networks," the entire teachings of all are incorporated herein by reference. This application is a continuation-in-part of 09/579,084 May 25, 2000.

INT-CL: [07] H01 Q 3/24

US-CL-ISSUED: 343/834; 342/372

US-CL-CURRENT: 343/834; 342/372

FIELD-OF-SEARCH: 343/834, 343/836, 343/837, 343/749, 343/835, 343/833, 342/372, 342/373, 342/367, 342/368, 455/422, 455/426

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

Search Selected

Search ALL

	PAT-NO	ISSUE-DATE	PATENTEE-NAME	US-CL
<input type="checkbox"/>	<u>3560978</u>	February 1971	Himmel et al.	343/106
<input type="checkbox"/>	<u>3725938</u>	April 1973	Black et al.	343/120
<input type="checkbox"/>	<u>3846799</u>	November 1974	Gueguen	343/833
<input type="checkbox"/>	<u>3950753</u>	April 1976	Chisholm	343/106
<input type="checkbox"/>	<u>4021813</u>	May 1977	Black et al.	343/768
<input type="checkbox"/>	<u>4099184</u>	July 1978	Rapshys	343/875
<input type="checkbox"/>	<u>4260994</u>	April 1981	Parker	343/854
<input type="checkbox"/>	<u>4290071</u>	September 1981	Fenwick	343/819
<input type="checkbox"/>	<u>4387378</u>	June 1983	Henderson	343/854
<input type="checkbox"/>	<u>4631546</u>	December 1986	Dumas et al.	343/833
<input type="checkbox"/>	<u>4700197</u>	October 1987	Milne	343/837
<input type="checkbox"/>	<u>5027125</u>	June 1991	Tang	342/368
<input type="checkbox"/>	<u>5235343</u>	August 1993	Audren et al.	343/816
<input type="checkbox"/>	<u>5293172</u>	March 1994	Lamberty et al.	343/701
<input type="checkbox"/>	<u>5294939</u>	March 1994	Sanford et al.	343/836
<input type="checkbox"/>	<u>5479176</u>	December 1995	Zavrel, Jr.	342/374
<input type="checkbox"/>	<u>5617102</u>	April 1997	Prater	342/374
<input type="checkbox"/>	<u>5767807</u>	June 1998	Pritchett	342/374
<input type="checkbox"/>	<u>5905473</u>	May 1999	Taenzer	343/834
<input type="checkbox"/>	<u>6034638</u>	March 2000	Thiel et al.	343/702
<input type="checkbox"/>	<u>6037905</u>	March 2000	Koscica et al.	343/701
<input type="checkbox"/>	<u>6100843</u>	August 2000	Proctor, Jr. et al.	342/368
<input type="checkbox"/>	<u>6304215</u>	October 2001	Proctor, Jr. et al.	342/372
<input type="checkbox"/>	<u>6317092</u>	November 2001	de Schweinitz et al.	343/753
<input type="checkbox"/>	<u>6337668</u>	January 2002	Ito et al.	343/833
<input type="checkbox"/>	<u>6400317</u>	June 2002	Rouphael et al.	342/367
<input type="checkbox"/>	<u>6404386</u>	June 2002	Proctor, Jr. et al.	342/368
<input type="checkbox"/>	<u>6473036</u>	October 2002	Proctor, Jr.	342/372

OTHER PUBLICATIONS

Durnan, G.J., "Switched Parasitic Feeds for Parabolic Antenna Angle Diversity," Microwave and Optical Tech. Letters, vol. 23, No. 4, Nov. 20, 1999, pp. 200-203.

Durnan, G.J., et al., "Optimization of Microwave Parabolic Antenna Systems Using Switched Parasitic Feed Structures," URSI National Science Meeting, Boulder, CO, Jan. 4-8, 2000, p. 323.

Giger, A.J., Low-Angle Microwave Propagation: Physics and Modeling, Norwood, MA: Artech House, 1991.

Harrington, R.F., "Reactively Controlled Antenna Arrays," IEEE APS International Symposium Digest, Amherst, MA Oct. 1976, pp. 62-65.

Harrington, R. F. "Reactively Controlled Directive Arrays," IEEE Trans. Antennas and Propagation, vol. AP-26, No. 3, May, 1978, pp. 390-395.

James, J.R. et al., "Electrically Short Monopole Antennas with Dielectric or Ferrite Coatings," Proc. IEEE, vol. 125, Sep. 1978, pp. 793-803.

James, J.R., et al., "Reduction of Antenna Dimensions with Dielectric Loading," Electronics Letters, vol. 10, No. 13, May, 1974, pp. 263-265.

King, R.W.P., "The Many Faces of the Insulated Antenna," Proc. IEEE, vol. 64, No. 2, Feb., 1976, pp. 228-238.

Long, S. A., et al., "The Resonant Cylindrical Dielectric Cavity Antenna," IEEE

Trans. Antennas and Propagation, vol. AP-31, No. 3, May 1983, pp. 406-412.
Long, S. A., et al., "Teh Resonant Cylindrical Dielectric Cavity Antenna," IEEE Trans. Antennas and Propagation, vol. AP-31, No. 3, May 1983, pp. 406-412.
Lu, J., et al., "Multi-beam Switched Parasitic Antenna Embedded in Dielectric for Wireless Communications Systems," Electronics Letters, vol. 37, No. 14, Jul. 5, 2001, pp. 871-872.
Luzwicz, J., et al., "A Reactively Loaded Aperture Antenna Array," IEEE Trans. Antennas and Propagation, vol. AP-26, No. 4, Jul., 1978, pp. 543-547.
Milne, R.M.T., "A Small Adaptive Array Antenna for Mobile Communications," IEEE APS International Symposium Digest, 1985, pp 797-800.
McAllister, M.W. et al., "Resonant Hemispherical Dielectric Antenna," Electronics Letters, vol. 20, No. 16, Aug. 1984, pp. 657-659.
McAllister, M.E. et al., "Rectangular Dielectric Resonator Antenna," Electronics Letters, vol. 19, No. 6, Mar. 1983, pp. 218-219.
Preston, S., et al., "Direction Finding Using a Switched Parasitic Antenna Array," IEEE APS International Symposium Digest, Montreal, Canada, 1997, pp. 1024-1027.
Preston, S.L., et al., "Base-Station Tracking in Mobile Communications Using a Switched Parasitic Antenna Array," IEEE Trans. Antennas and Propagation, vol. 46, No. 6, Jun., 1998, pp. 841-844.
Preston, S.L., et al., "Systematic Approach to the Design of Directional Antennas Using Switched Parasitic and Switched Active Elements," Asia Pacific Microwave Conference Proceedings, Yokohama, Japan, 1998, pp. 531-534.
Preston, S.L., et al., "Size Reduction of Switched Parasitic Directional Antennas Using Genetic Algorithm Optimisation Techniques," Asia Pacific Microwave Conference Proceedings, Yokohama, Japan, 1998, pp. 1401-1404.
Preston, S.L., et al., "A Multibeam Antenna Using Switched Parasitic and Switched Active Elements for Space-Division Multiple Access Applications," IEICE Trans. Electron., vol. E82-C, No. 7, Jul. 1999, pp. 1202-1210.
Preston, S.L., et al., "Electronics Beam Steering Using Switched Parasitic Patch Elements," Electronics Letters, vol. 33, No. 1, Jan. 2, 1997, pp. 7-8.
Ruze, J., "Lateral-Feed Displacement in a Paraboloid," IEEE Trans. Antennas and Propagation, vol. 13, 1965, pp. 660-665.
Scott, N.L., et al., "Diversity Gain from a Single-Port Adaptive Antenna Using Switched Parasitic Elements Illustrated with a Wire and Monopole Prototype," IEEE Trans. Antennas and Propagation, vol. 47, No. 6, Jun. 1999, pp. 1066-1070.
Sibille, A. et al., "Circular Switched Monopole Arrays for Beam Steering Wireless Communications," Electronics Letters, vol. 33, No. 7, Mar. 1997, pp. 551-552.
Vaughn, R., "Switched Parasitic Elements for Antenna Diversity," IEEE Trans. Antennas and Propagation, vol. 47, No. 2, Feb. 1999, pp. 399-405.

ART-UNIT: 2821

PRIMARY-EXAMINER: Clinger; James

ATTY-AGENT-FIRM: Hamilton, Brook, Smith & Reynolds, P.C.

ABSTRACT:

An antenna apparatus which can increase capacity in a cellular communication system. The antenna operates in conjunction with a mobile subscriber unit and provides a plurality of antenna elements. At least one active antenna element is active and essentially centrally located within multiple passive antenna elements. The passive antenna elements are coupled to selectable impedance components. Through proper control of the passive antenna elements, the cellular communication system directs an antenna beam pattern toward an antenna tower of a base station to maximize gain, and, consequently, signal-to-noise ratio. Thus, optimum reception is achieved during, for example, an idle mode which receives a pilot signal. The antenna array creates a beamformer for signals to be transmitted from the mobile subscriber unit, and a directional receiving array to more optimally detect and receive signals transmitted from the base station. By directionally receiving and transmitting signals, multipath fading is greatly reduced as well as intercell interference. Various techniques for determining the proper phase of each antenna element are accommodated.

50 Claims, 21 Drawing figures